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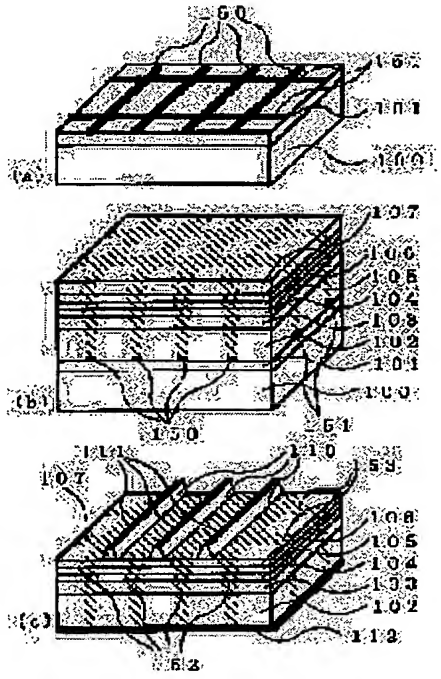
(54) SEMICONDUCTOR LIGHT EMITTING DEVICE AND MANUFACTURE THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent the decline in the light emission efficiency by forming a light emitting region generated by current injection which is one of active layers, in other region than a region right above a growth suppressing structure.
SOLUTION: On a sapphire substrate 100, selectively grown masks 150, 151 are so formed as to cross at right angles each other. After that, an n-GaN continuous film semiconductor layer 102 is grown. Then, a mesa stripe 110 is formed nearly parallelly with the selectively grown mask 150 in other region than a region 152 right above the selectively grown mask 150. Nextly, a p-type electrode 111 of a stripe geometry is formed on an upper face of the nesa stripe 110 and then a backside of a wafer is polished to expose the n-GaN continuous film semiconductor layer 102 and an n-type electrode 112 is formed on the entire surface of the n-GaN continuous film semiconductor layer 102. After that, at a position away from the selectively grown mask 151, a mirror surface which constitutes a laser resonator is formed by cleaving. By specifying the shape of the selectively grown masks, the relative position of the mesa stripe 110, and the relative position of the laser resonator mirror for cleaving, the decline in the light emission efficiency can be prevented.



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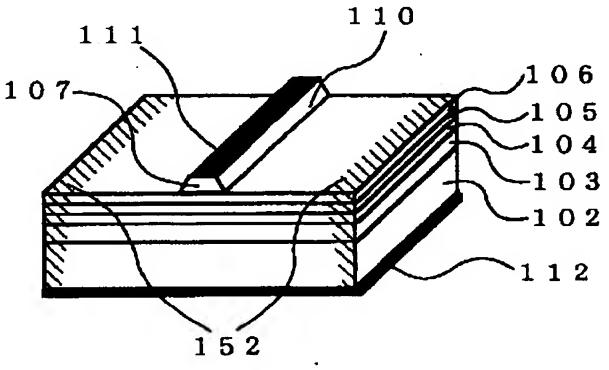
(54)【発明の名称】　半導体発光素子及びその製造方法

(57)【要約】

【課題】　部分的成長抑制構造を利用して、基板と格子定数または熱膨張係数が異なる連続膜半導体層を形成した上に、さらに半導体発光素子を形成する場合の発光効率の低下および信頼性の悪化を防止する。

【解決手段】　成長抑制構造上への結晶成長により得られる成長抑制構造上方領域を含む連続膜半導体層の上に形成された半導体発光素子において、活性層の内、電流注入により光を発生する発光領域が上記成長抑制構造上方領域以外の領域に形成されているようにする。



【特許請求の範囲】
【請求項１】　成長抑制構造上への結晶成長により得られる成長抑制構造直上領域を含む連続膜半導体層と、光を発生させる活性層とを有する半導体発光素子であって、
該活性層の内、電流注入により光を発生する発光領域が前記成長抑制構造直上領域以外の領域に形成されていることを特徴とする半導体発光素子。
【請求項２】　前記発光領域は成長抑制構造直上領域から３０μｍ以上離れた位置に形成されていることを特徴とする請求項１に記載の半導体発光素子。
【請求項３】　前記発光領域と前記成長抑制構造直上領域との間の領域では、前記活性層が除去されていることを特徴とする半導体発光素子。
【請求項４】　基板上に成長抑制構造を形成する第１工程と、
前記基板および前記成長抑制構造の両方を連続して覆うように前記基板と格子定数または熱膨張係数が異なる連続膜半導体層を形成する第２工程と、
前記連続膜半導体層の上に光を発生させる活性層を含む多層構造体を形成する第３工程と、
前記成長抑制構造部の直上領域を除いて前記活性層における発光領域を規定するための構造を形成する第４工程と、を有することを特徴とする半導体発光素子の製造方法。
【請求項５】　半導体発光素子をウェハーから複数個の半導体発光素子に分割する工程を有する半導体発光素子の製造方法であって、
前記第４工程後、前記成長抑制構造直上の前記活性層が半導体発光素子に含まれないように半導体発光素子をウェハーから分割する第５工程とを含むことを特徴とする請求項４に記載の半導体発光素子の製造方法。
【請求項６】　前記第５工程において、前記成長抑制構造直上の端から３０μｍ以内の領域に残存する前記活性層が、半導体発光素子に含まれないように半導体発光素子を分割することを特徴とする請求項５に記載の半導体発光素子の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、半導体発光素子に関し、特に、基板上に基板とは格子定数または熱膨張係数の異なる半導体材料にて形成された信頼性の高い半導体発光素子に関する。
【０００２】
【従来の技術】半導体発光素子を構成する結晶材料とは格子定数が３％以上異なる基板上へ形成する場合や、熱膨張係数が１０％以上異なる基板上へ半導体結晶を成長する場合には、まず基板の上に半導体発光素子を構成する材料と格子定数や熱膨張係数がほぼ等しい（格子定数、熱膨張係数とも１％以内）結晶材料を厚く成長させ連続膜半導体層を形成した上に半導体発光素子を形成する試みがなされている。連続膜半導体層の上に積層した半導体層は結晶欠陥が低減することが報告されている。このような発光素子の代表例として、図８に、サファイア基板８００上に、ＧａＮ層を厚く結晶成長させて連続膜半導体層を形成し、その上に青色発光ダイオード（ＬＥＤ）を形成した従来技術による例を示す。
【０００３】この従来例のＬＥＤの作製方法を説明する。サファイア基板８００上に、まずハライド気相成長法（ＨＶＰＥ法）によりＧａＮ層８０１を５μｍ厚に厚く成長させる。次に、ＧａＮ層８０１表面にSiO_2からなる選択成長マスク８０２を格子状（２００μｍピッチの２０μｍ幅のSiO_2ストライプが互いに直交する形）に形成する。以上までに作製された工程断面図を図８（ａ）に示す。
【０００４】次に、このサファイア基板８００上にＨＶＰＥ法によりｎ型ＧａＮ連続膜半導体層８０３を３００μｍ厚成長させる。この時、ＨＶＰＥ工程により成長されたｎ型ＧａＮ連続膜半導体層８０３は、サファイア基板８００が露出した部分から成長が始まるが、その厚さが増すに伴い、SiO_2からなる選択成長用マスク８０２上へ張り出すように左右へも成長し、最終的には２０μｍ幅のSiO_2からなる選択成長マスク８０２上を覆った。このようにして、表面が平坦なｎ型ＧａＮ連続膜半導体層８０３が形成された。
【０００５】次に、このサファイア基板８００上にｎ型ＧａＮ連続膜半導体層８０３が形成されたウェハーに、有機金属気相成長法（ＭＯＣＶＤ法）によりｎ－ＧａＮクラッド層８０４、ＩｎＧａＮ活性層８０５、ｐ－ＧａＮコンタクト層８０６が形成された。以上までに作製された工程断面図を図８（ｂ）に示す。
【０００６】次に、図９の（ａ）従来例のＬＥＤの上面構造図と（ｂ）従来例ＬＥＤのＡ－Ａ’断面図に示すように、３００μｍ角の発光領域８１０を残し、その回りを取り囲むように通常のフォトリソグラフィー技術とドライエッチング技術を用いてｐ－ＧａＮコンタクト層８０６、ＩｎＧａＮ活性層８０５、ｎ－ＧａＮクラッド層８０４を貫通するように除去し、ｎ型ＧａＮ連続膜半導体層８０３を露出させた。最後に、ｎ型ＧａＮ連続膜半導体層８０３の表面にｎ型電極８０７を、３００μｍ角のｐ－ＧａＮコンタクト層８０６の表面に光透過性を有するｐ型電極８０８をそれぞれ形成した。このようにして、作製したウェハーから、発光領域８１０の周辺でスクライブし、個々のＬＥＤを切り出し素子とした。このようにして作製する従来例のＬＥＤが報告されている。
【０００７】
【発明が解決しようとする課題】しかしながら、このようにして作製したＬＥＤの特性を当該発明者が試験した結果、２０ｍＡの電流を注入した場合の発光効率（電子の光子への変換効率）が個々の素子により０．３％から

１０％と大きく異なり、所望の５％以上の発光効率が得られる歩留まりが２％と非常に低いことや、８０℃の条件下での約１００時間の初期信頼性試験にて全ての素子の発光効率が試験開始時の約３０％以下に激減することが新たに判明した。

【０００８】これらの従来素子の不良について、当該発明者が詳細な検討を行った結果、下記のような事実が判明した。

（１）選択成長マスク８０２の存在する選択成長マスク直上領域８１１に位置するＩｎＧａＮ活性層８０５部分での発光が非常に小さい。また、この発光効率の低下はチップの発光領域８１０の周辺領域より発光領域８１０の中央領域に選択成長マスク直上領域８１１が位置する場合に特に顕著になることも分かった。これにより、選択成長マスク直上領域８１１が発光領域８１０のどの部分に位置しているかにより、大きく発光効率が変化する。

（２）上記の信頼性不良の素子においても、１００時間の信頼性試験走行後では、選択成長マスク直上領域８１１（幅２０μｍ）のＩｎＧａＮ活性層８０５はその近傍の両側約３０μｍを含め、合計８０μｍの領域で発光がほとんど認められない。

【０００９】さらに従来例素子の結晶解析を行った結果、選択成長マスク直上領域８１１に位置するＩｎＧａＮ活性層８０５には、厚さ３００μｍのｎ型ＧａＮ連続膜半導体層８０３を貫通して結晶転移が集中して導入されていることが明確になった。図１０にＩｎＧａＮ活性層８０５における結晶転移の密度を、選択成長マスク８０２端からの距離をパラメータとして測定した結果を示す。幅２０μｍの選択成長マスク直上領域８１１のＩｎＧａＮ活性層８０５には密度$10^{12}cm^{-2}$の結晶転移が集中しており、さらに選択成長マスク８０２の端から１０μｍ離れた位置でも$10^{11}cm^{-2}$の転移が観測された。選択成長マスク８０２の端から離れるにつれて結晶転移は減少し、３０μｍ以上離れた場所のＩｎＧａＮ活性層８０５では結晶転移は10^{7}～$10^{8}cm^{-3}$にまで減少した。このような傾向は、上記のように作製されたウェハーのいずれの部分でも観測された。

【００１０】また、同様な方法により半導体レーザを上述のようなｎ型ＧａＮ連続膜半導体層８０３上に、発光領域に選択成長マスク直上領域８１１が含まれ、発振閾値電流が７００ｍＡと大きく、かつ素子寿命も室温において１秒程度と非常に短かった。

【００１１】上記のように、従来技術においては、下記のような問題点が明らかになった。

（１）選択成長法を用いて作製した連続膜半導体層上の発光素子において、選択成長マスク直上領域８１１において発光効率の低下が見られるため、発光領域に選択成長マスク直上領域が含まれるチップでは劇的に発光効率が低下する。

（２）ＧａＮ連続膜の上に形成した半導体レーザ素子の寿命が短く、半導体レーザ素子は得られなかった。

【００１２】このため、基板上に、基板と異なる格子定数や熱膨張係数を有する連続膜半導体層を成長させ、その上に形成する半導体発光素子に、格子定数差や熱膨張係数差から引き起こされる発光効率の低下や信頼性不良を防止することは不可能であった。

【００１３】従って、部分的成長抑制構造を利用して、基板と格子定数または熱膨張係数が異なる連続膜半導体層を形成した上に、さらに半導体発光素子を形成する場合における発光効率の低下および信頼性の悪化を防止することを目的とする。

【００１４】

【課題を解決するための手段】本発明の請求項１は、成長抑制構造上への結晶成長により得られる成長抑制構造直上領域を含む連続膜半導体層と、光を発生させる活性層とを有する半導体発光素子であって、該活性層の内、電流注入により光を発生する発光領域が前記成長抑制構造直上領域以外の領域に形成されていることにより構成されている。

【００１５】本発明における請求項２は、前記発光領域は成長抑制構造直上領域から３０μｍ以上離れた位置に形成されていることにより構成され、さらに請求項３は前記発光領域と前記成長抑制構造直上領域との間の領域では、前記活性層が除去されていることにより構成されている。

【００１６】一方、請求項４は、基板上に成長抑制構造を形成する第１工程と、前記基板および前記成長抑制構造の両方を連続して覆うように前記基板と格子定数または熱膨張係数が異なる連続膜半導体層を形成する第２工程と、前記連続膜半導体層の上に光を発生させる活性層を含む多層構造体を形成する第３工程と、前記成長抑制構造部の直上領域を除いて前記活性層における発光領域を規定するための構造を形成する第４工程と、を有することにより構成されており、さらに請求項５は、半導体発光素子をウェハーから複数個の半導体発光素子に分割する工程を有する半導体発光素子の製造方法であって、前記第４工程後、前記成長抑制構造直上の前記活性層が半導体発光素子に含まれないように半導体発光素子をウェハーから分割する第５工程とを含むことにより構成され、請求項６は、前記第５工程において、前記成長抑制構造直上の端から３０μｍ以内の領域に残存する前記活性層が、半導体発光素子に含まれないように半導体発光素子を分割することにより構成されている。

【００１７】

【発明の実施の形態】以下に本発明を実施した例を用いて説明する。

（実施の形態１）図１に本発明を実施した半導体レーザ素子の一例を示す。本半導体レーザ素子は、ｎ－ＧａＮ連続膜半導体層１０２、ｎ－ＧａＮバッファ層１０３、

ｎ－$Al_{0.1}Ga_{0.9}N$クラッド層１０４、多重量子井戸活性層１０５、ｐ－$Al_{0.1}Ga_{0.9}N$クラッド層１０６、ｐ－ＧａＮコンタクト層１０７から構成されており、リッジ導波路としてレーザの発光領域を規定するためのメサストライプ１１０、さらには、電流注入用のｐ型電極１１１、ｎ型電極１１２から構成されている。

【００１８】次に、図２を用いて本実施例素子の作製工程を説明する。まず、サファイア基板１００の上にＭＯＣＶＤ法によりＧａＮバッファ層１０１を１μｍ厚成長させる。次に、ＧａＮバッファ層１０１の表面上に通常のスパッタ法によりSiO_2膜を０．４μｍ厚形成させた後、通常のフォトリソグラフィ技術とエッチング技術により幅１０μｍでピッチ１５０μｍの周期的SiO_2からなる選択成長マスク１５０と幅１０μｍでピッチ５００μｍの周期的SiO_2からなる選択成長マスク１５１とが互いに直交する形状に形成した。以上までに作製された半導体レーザ素子の工程断面図を図２（ａ）に示す。

【００１９】続いて、このウェハー上にＨＶＰＥ法により、ｎ－ＧａＮ連続膜半導体層１０２を１５０μｍ厚成長させた。基板温度は１０２０℃として３５分の成長により１５０μｍ厚の成長が完了した。この成長時、選択成長マスク１５０、１５１が成長抑制構造として働くため、従来例にて説明のように、成長初期にはＧａＮバッファ膜１０１が露出した領域でのみ成長は起こり、次第に、選択成長マスク１５０、１５１上に横方向に成長が進み、最終的に１５０μｍ厚の成長が終了した段階では、ｎ－ＧａＮ連続膜半導体層１０２は連続膜を呈しており、その表面はスムースになった。

【００２０】次に、引き続きＭＯＣＶＤ法により、このｎ－ＧａＮ連続膜半導体層１０２の上に、ｎ－ＧａＮバッファ層１０３を０．５μｍ厚、ｎ－$Al_{0.1}Ga_{0.9}N$クラッド層１０４を０．２μｍ厚、４ｎｍ厚の$In_{0.25}Ga_{0.75}N$井戸層２層と３ｎｍ厚の$In_{0.05}Ga_{0.95}N$バリア層３層からなる多重量子井戸活性層１０５、ｐ－$Al_{0.1}Ga_{0.9}N$クラッド層１０６を０．２μｍ厚、ｐ－ＧａＮコンタクト層１０７を０．７μｍ厚成長させた。以上までに作製された半導体レーザ素子の工程断面図を図２（ｂ）に示す。

【００２１】続いて、幅２μｍ、高さ０．７μｍのメサストライプ１１０を選択成長マスク１５０の直上領域１５２以外の領域に選択成長マスク１５０とほぼ平行に形成した。この時、メサストライプ１１０が素子の上方から観察して隣り合う選択成長マスク１５０のほぼ中央に位置するようにした。このメサストライプ１１０の形成には通常のフォトリソグラフィ技術とドライエッチング技術を適用した。この後、メサストライプ１１０を上面にストライプ状のｐ型電極１１１を形成した後、ウェハー裏面を研磨することによりウェハー厚さを約１２０μｍとし（すなわち、サファイア基板１００、ＧａＮバッファ層１０１、選択成長マスク１５０、１５１を完全に除去し、ｎ－ＧａＮ連続膜半導体層１０２がウェハー裏面に露出するようにし）、ｎ－ＧａＮ連続膜半導体層１０２の露出した裏面の全面にｎ型電極１１２を形成した。以上までに作製された半導体レーザ素子の工程断面図を図２（ｃ）に示す。

【００２２】次に、劈開によりレーザ共振器を構成するミラー面を形成した。この劈開工程は以下のようにして実施した。まず、ウェハー裏面（すなわちｎ－ＧａＮ連続膜層１０３側）の隅近傍の２箇所にけがき傷を入れ、このけがき傷の位置において、選択成長マスク１５１を形成した方向と平行方向に劈開してレーザ共振器ミラーを形成した。この時、２箇所のけがき傷は互いに隣接する選択成長マスク１５１のエッジ部分から５０μｍ離れた位置に形成し、選択成長マスク１５１の直上領域１５３がレーザ素子に含まれないようにした。従って、レーザ共振器長は４００μｍであった。最後に、選択成長マスク１５０の直上領域１５２の部分をスクライブし、個々のレーザチップに分割した。以上の工程を経て図１に示すレーザ素子が完成する。

【００２３】以上のようにして作製したレーザ素子は、閾値電流２５ｍＡでレーザ発振が実現できた。また、本レーザ素子を５０℃雰囲気、３ｍＷ出力の条件下において信頼性試験を実施した結果、初期の５０時間以内に故障に至るレーザ素子を除いて、ほとんどの素子において１０００時間以上の寿命が確認でき、メディアン寿命（試験した半分の素子が故障する時間）は１５００時間であった。この信頼性は当該素子を光ディスク用光源として利用する場合にでも十分な特性である。この信頼性の改善は、本レーザ素子では、ｎ－ＧａＮ連続膜半導体層１０２を成長させるために形成した成長抑制構造である選択成長マスク１５０、１５１上において結晶欠陥が集中する直上領域１５２、１５３がレーザ素子の発光領域（この場合は活性層１０５に電流が選択的に注入されるメサストライプ１１０が形成されている部分）に含まれないように、選択成長マスク１５０、１５１の形状と、選択成長マスク１５０に対するメサストライプ１１０の相対位置、および選択成長マスク１５１に対するレーザ共振器ミラーの劈開のための相対位置を設定したことによるものと理解できる。

【００２４】上記の発明を実施したレーザ素子では、メサストライプ１１０を隣接する選択成長マスク１５０の直上領域１５２同士の中央となるように（すなわち、選択成長マスク１５０の端から７０μｍ離れた部分に）形成されている。上記の実施例素子と同様の構造で、メサストライプ１１０の直上領域１５２（すなわち選択成長マスク１５０）端からの距離を０μｍ（すなわち直上領域１５２内にメサストライプ１１０を形成した場合）、１０μｍ、２０μｍ、３０μｍ、５０μｍ、７０μｍと変化させたレーザ素子を作製し、上記と同様の信頼性試

験を実施した。この時、素子分離ためのスクライブ位置はいずれの素子においても隣接するメサストライプ１１０の中心付近とし、スクライブ位置のメサストライプ１１０との相対距離を一定とした。その結果を図３に示す。横軸は直上領域１５２の中心からメサストライプ１１０までの距離、縦軸はメディアン寿命を示している。この結果から、実用上必要とされる１０００時間以上のメディアン寿命を確保するためにはメサストライプ１１０を直上領域１５２から３０μｍ以上離れた位置に形成することが必要であることが分かった。

【００２５】（実施の形態２）次に、本発明を発光ダイオードに適用した場合について述べる。図４に第２の実施形態素子の構造図を示す。ｎ－ＧａＮ連続膜半導体層４０１、ｎ－ＧａＮバッファ層４０２、$In_{0.1}Ga_{0.9}$Ｎ歪み緩和層４０３、$In_{0.5}Ga_{0.5}$Ｎ単一量子井戸活性層４０４、ｐ－$Al_{0.2}Ga_{0.8}$Ｎ蒸発防止層４０５、ｐ－ＧａＮコンタクト層４０６、およびｎ型電極４０７、ｐ型電極４０８から構成されている。また本実施例の素子ではメサ４１０により発光領域が規定されている。

【００２６】次に、本発光素子の作製方法について説明する。まず、サファイア基板４００表面にダイシングにより幅４０μｍ、深さ５０μｍの溝構造４５０を４００μｍピッチで格子状に形成する。以上までに作製された半導体素子の工程断面図を図５（ａ）に示す。

【００２７】次にＨＶＰＥ法により、厚さ３００μｍのｎ－ＧａＮ連続膜半導体層４０１を成長させる。この時、サファイア基板４００に形成した溝構造４５０があるため成長初期においてｎ－ＧａＮ連続膜半導体層４０１は平坦な面としての成長ができないが、成長層厚を増すに従って徐々に左右の壁からの成長により溝構造４５０を埋まり、表面の溝は平坦に埋め込まれることとなった。すなわち、実効的に溝４５０での成長が遅いのと同様の効果を実現でき、３００μｍの成長終了時にはｎ－ＧａＮ連続膜層４０１は、連続した表面が平坦な単一の層にすることができた。

【００２８】次に、分子線エピタキシアル法（ＭＢＥ法）により、ｎ－ＧａＮ連続膜半導体層４０１上にｎ－ＧａＮバッファ層４０２を０．４μｍ厚、$In_{0.2}Ga_{0.8}$Ｎ歪み緩和層４０３を０．０５μｍ厚、$In_{0.45}Ga_{0.55}$Ｎ単一量子井戸活性層４０４を４ｎｍ厚、ｐ－$Al_{0.1}Ga_{0.9}$Ｎ蒸発防止層４０５を０．１μｍ厚、ｐ－ＧａＮコンタクト層４０６を０．４μｍ厚成長させた。以上までに作製された発光素子の工程断面図を図５（ｂ）に示す。

【００２９】さらに、通常のフォトリソグラフィ技術とドライエッチング技術を用いて$In_{0.45}Ga_{0.55}$Ｎ単一量子井戸活性層４０４を含む３００μｍ角メサ４１０を周期的に残し、その間の領域を１００μｍ幅でエッチングし、ｎ－ＧａＮ連続膜半導体層４０１をエッチング底面に露出させた。すなわち、エッチングを行った領域は４００μｍピッチの格子状の形状となり、これにより、溝構造４５０の上にＭＢＥ成長された欠陥を多く含む溝構造４５０の直上領域４５１とその周辺に含まれる$In_{0.45}Ga_{0.55}$Ｎ単一量子井戸活性層４０４を完全に除去した。本実施の形態では溝構造４５０が成長抑制構造となる。以上までに作製された発光素子の工程断面図を図５（ｃ）に示す。

【００３０】次に、ウェハーの裏面を研磨し、サファイア基板４００を完全に除去しｎ－ＧａＮ連続膜半導体層４０１をウェハー裏面に露出させた後、このｎ－ＧａＮ連続膜半導体層４０１にｎ型電極４０７を、メサ４１０の表面に光透過性のｐ型電極４０８を形成した。最後に、溝構造４５０の直上領域４５１でスクライブすることにより、個々の発光ダイオードチップとした。以上までに作製された発光素子の工程断面図を図４に示す。

【００３１】このようにして作製された発光ダイオードの電子の光子への変換効率を測定したところ、実用上問題がないとみなすことが出来る変換効率５％以上の素子の歩留まりが８５％と高かった。さらに、本実施例素子を従来例素子と同様の条件にて信頼性試験を実施したところ、１０００時間経過後においても、試験開始時の９５～１０３％の発光強度を得ることができ、実用上問題のない信頼性が確保された。

【００３２】本実施形態の発光素子における発光領域は、$In_{0.45}Ga_{0.55}$Ｎ単一量子井戸活性層４０４が残存しているメサ４１０部に相当する。ｎ－ＧａＮ連続膜半導体層４０１成長時に成長抑制構造として利用した溝構造４５０の直上領域４５１を除いた領域にメサ４１０が形成されているため、作製された全ての発光素子において発光領域には溝構造４５０の直上領域４５１は含まれていない。また、エッチングにより$In_{0.45}Ga_{0.55}$Ｎ単一量子井戸活性層４０４が除去された幅は１００μｍであり、メサ４１０部の発光領域は幅４０μｍの溝構造４５０の端から３０μｍ離れたところに形成されていることとなる。上記のように発光効率の高い素子を歩留まり良く得ることができ、かつ問題のない信頼性を実現できるのは、ＨＶＰＥ法およびＭＯＣＶＤ法による結晶成長工程により溝構造４５０の直上領域４５１に集中的に導入された結晶欠陥の影響が、$In_{0.45}Ga_{0.55}$Ｎ単一量子井戸活性層４０４での発光に悪影響を与えず、比較的結晶欠陥の少ない部分に制御性良く発光領域を配置することが可能となったためと考えられる。

【００３３】なお、上記の実施形態の発光素子において、発光素子作製工程および構造はほぼ同等とし、溝構造４５０のピッチのみを上記の例の４００μｍから５００μｍおよび３００μｍに変化させた場合の発光素子を試作した。この場合においてもメサ４１０の大きさや作製ピッチはそれぞれ３００μｍ、４００μｍと上記の実施形態素子のままとした。これらの発光素子の発光特性

を測定したところ、溝４５０のピッチを３００μｍと小さくした素子では、５％以上の発光効率が得られる歩留まりは１６％と激減した。一方、５００μｍと広げた発光素子では３８％であった。これは、溝構造４５０のピッチが、個々の発光ダイオードを形成するメサ４１０の作製ピッチと同一であることが重要であることを示している。従って、同一面積のウェハーからより多くの発光素子を作製するためには、全ての発光素子において溝構造の直上領域４５１が発光領域に含有されないようにすべきである。この意味に置いて、溝構造４５０のピッチをメサ４１０作製ピッチの整数倍にしても良いことは言うまでもない。

【００３４】（実施形態３）次に、成長抑制構造自体をレーザ素子に残存させた実施形態について説明する。図６に本実施形態の素子構造図を示す。本実施形態の素子構造はｎ－ＳｉＣ基板６００と、ＧａＮバッファ層６０１、ｎ－ＧａＮ連続膜半導体層６０２、ｎ－ＧａＮバッファ層６０３、ｎ－$Al_{0.1}Ga_{0.9}N$クラッド層６０４、３ｎｍ厚の$In_{0.1}Ga_{0.85}Al_{0.05}N$バリア層３層と３ｎｍ厚の$In_{0.2}Ga_{0.8}N$量子井戸層２層からなる多重量子井戸活性層６０５、ｐ－$Al_{0.1}Ga_{0.9}N$クラッド層６０６、ｐ－ＧａＮコンタクト層６０７、からなる半導体層構造と、ｐ型電極６１１、ｎ型電極６１２、さらには、導波路と電流通路を規定するメサストライプ６１０、共振器ミラーとなるエッチドミラー６１３を有している。

【００３５】以下に、本実施形態のレーザ素子の作製方法について説明する。（工程図は図２と類似しているのでここでは省略する。）まず、ｎ－ＳｉＣ基板６００上に、SiN_xからなる幅１０μｍで周期が１００μｍの選択成長マスク６５０と、幅が１０μｍで周期が４００μｍの選択成長マスク６５１とが互いに直交するように形成した。このウェハー上にＭＯＣＶＤ法によりＧａＮバッファ層６０１を３０ｎｍ厚、ｎ－ＧａＮ連続膜半導体層６０２を１００μｍ厚、ｎ－ＧａＮバッファ層６０３を０．１μｍ、ｎ－ＡｌＧａＮクラッド層６０４を０．３μｍ厚、多重量子井戸活性層６０５、ｐ－ＡｌＧａＮクラッド層６０６を０．３μｍ厚、ｐ－ＧａＮコンタクト層６０７を１．０μｍ厚連続的に結晶成長させる。この時、ｎ－ＧａＮ連続膜半導体層６０２の成長においては、厚さが３０μｍ以下の状態では選択成長マスク６５０、６５１上では未成長部分が残存しており、結晶は連続した膜を呈していなかったが、さらに成長を続けて厚さが１００μｍに達した段階では、ｎ－ＧａＮ連続膜半導体層６０２表面は実施形態１と同様に平坦で連続した単膜を呈しており、その上に連続的に形成された積層構造に含まれる各層６０３～６０７もまた平坦な層として成長された。

【００３６】次に、通常のフォトリソグラフィ技術とエッチング技術を利用し、高さ０．８μｍ、幅２μｍのメサストライプ６１０を選択成長マスク６５１と平行に形成した。このメサストライプ６１０はレーザ導波路を活性層６０５に形成するばかりでなく、活性層６０５に注入される電流の通路もメサストライプ６１０直下近傍部分に規定し、効率よく電子をレーザ光に変換する働きをする。本工程において、メサストライプ６１０は、両側の選択成長マスク６５１の直上領域６５３の中央、すなわち選択成長マスク６５１の端とメサストライプ６１０の端の間隔が３９μｍとなるように形成した。

【００３７】次に、通常のエッチドミラー形成のためのフォトリソグラフィ技術とドライエッチング技術を利用し、レーザ共振器ミラーとなるエッチドミラー６１３を形成した。この時、エッチドミラー６１３が選択成長マスク６５０に平行であり、かつ選択成長マスク６５０の直上領域６５２の活性層６０５をエッチングより除去するように、選択成長マスク６５０の直上領域６５２を中心として全幅１００μｍの領域にエッチングを施し、ｎ－ＧａＮ連続膜半導体層６０２がエッチング底面に露出するまでエッチングを行った。この工程によりレーザ共振器となるべき一組の共振器ミラーが形成され、本実施形態のレーザ素子における共振器長は３００μｍとした。すなわち、選択成長マスク６５０の周期と同じ４００μｍ周期でエッチドミラー形成のためのエッチングを実施したことになる。

【００３８】最後に、メサストライプ６１０上面にｐ型電極６１１を、ｎ－ＳｉＣ基板６００裏面全面にｎ型電極６１２を形成した後、選択成長マスク６５０、６５１の直上領域６５２、６５３の部分でスクライブすることにより個々のレーザ素子に分割した。

【００３９】本実施形態のレーザ素子を実施形態２の６０℃雰囲気下、５ｍＷ光出力の条件下での信頼性試験を実施したところ、初期２４時間の異常劣化を示した素子を除いて、全て１０００時間以上の寿命を有することが確認できた。この場合のメディアン寿命は約１６００時間であった。このように、信頼性の高いレーザが実現できたのは、選択成長マスク６５０の直上領域６５２が発光領域であるメサストライプ６１０に全く含まれず、レーザ素子の劣化を引き起こす結晶欠陥が少ない領域のみの活性層６０５が発光に寄与している効果と推察される。

【００４０】ところで、実施形態の１においてはレーザ素子の劈開位置は選択成長マスク１５０の直上領域１５２外の部分に限られていた。これは、選択成長マスク１５０の直上領域１５２で劈開した場合に、レーザの発光領域となるメサストライプ１１０内の破壊し易い劈開面近傍に結晶欠陥が多く含まれる選択成長マスクの直上領域１５２が包含され、素子を動作させた時に瞬時に劣化することを避けるためである。しかし、実施形態１におけるように選択成長マスク１５０の直上領域１５２の近傍にて選択成長マスク１５０の直上領域１５２に平行に

劈開をした場合、部分的に劈開面に段差が生じ、結果として一部の素子にてメサストライプ１１０に選択成長マスク１５０の直上領域１５２が含まれてしまう場合があった。これは、選択成長マスク１５０の直上領域１５２に結晶欠陥が多く含まれており、結晶として弱く、より割れやすいことが原因と考えられる。すなわち、選択成長マスク１５０の直上領域１５２で結晶が劈開しやい性質を持ち合わせているのに関わらず、実施形態１ではその近傍を劈開していたためである。この現象は、劈開により素子を分割する場合のみならず、スクライブにより素子を分割する場合にも同様の現象が観測され、選択マスク１５１の直上領域１５３でスクライブすした場合に比べて、選択マスク１５１の直上領域１５３近傍で選択マスク１５１の直上領域１５３と平行に制御性良くスクライブした場合の歩留まりは低かった。

【００４１】一方、本実施形態素子では、素子を分割する際の４面全てのスクライブによる素子分割位置を選択成長マスク６５０、６５１の直上領域６５２、６５３に限定できるため、素子分割時に所定の位置にてスクライブが起こり、メサストライプ６１０に選択マスクの直上領域６５２が含まれたり、所定の形状（上方から観察して図6に示すように直方形）から素子の形状がずれることは無かった。これにより、素子をマウントする際の素子形状認識においても、エラーを低下させることができ、素子マウント歩留まりも改善することができた。この点も、本実施形態素子における大きなメリットであった。

【００４２】（実施形態４）次に、成長抑制構造の直上領域の活性層が素子に残存している場合の本発明の実施形態を発光ダイオードの例を用いて説明する。図７に、本実施形態の発光素子の上面より観察した構造図を示す。ＧａＮ連続膜層の形成方法や半導体積層構造は実施形態２の場合と同じとした（本実施形態例の説明では共通する各層の標記は実施例２と同一とする）。実施形態２と異なるのは、$In_{0.45}Ga_{0.55}N$単一量子井戸活性層４０４を含むメサ７１０の形状が図７のような形状を有しており、かつそのサイズを３９０μｍ角と大きくした点である。このため、本実施形態の発光素子では、ｎ－ＧａＮ連続膜層４０１成長時の成長抑制構造たる溝構造４５０の直上領域７５１に位置する$In_{0.45}Ga_{0.55}N$単一量子井戸活性層４０４がメサ７１０内に含まれた形となっている。

【００４３】しかし、本実施形態の発光素子では、ｐ型電極７１１を３００μｍ角として、メサ７１０の中央領域に配置した。すなわち、溝構造４５０の直上領域７５１および直上領域７５１の端から３０μｍの領域においてはｐ型電極が形成されないようにした。一方、ｎ型電極７１２は$In_{0.45}Ga_{0.55}N$単一量子井戸活性層４０４が除去された発光素子の一角に図７のように形成した。

【００４４】このような構成とすることにより、ｐ型コンタクト層４０６、ｐ型電極７１１から注入される電流はｐ－ＧａＮコンタクト層４０６が、比較的抵抗率の高いｐ－ＧａＮからなっており、かつ０．４μｍとその膜厚が薄いために、ｐ型コンタクト層４０６中ではほとんど電流が横方向に拡散せず、ｐ型電極７１１の直下の$In_{0.45}Ga_{0.55}N$単一量子井戸活性層４０４にのみ電流を注入することができる。

【００４５】当該実施形態の発光素子の特性を評価した結果、５％以上の電子－光子変換効率を有するチップは、検査した内の７９％に達し、従来技術により構成された発光素子より格段の改善が認められた。また、これらの発光素子の信頼性試験（条件は実施形態２と同様）を行ったところ、１０００時間経過後の発光輝度は試験当初の発光輝度に対して８５～９９％の範囲となり、全ての発光素子が実用上問題ないことが確認された。

【００４６】以上、実施形態の発光素子においては、ＧａＮ連続膜半導体層を用いて窒化ガリウム系の発光素子を作製した例を説明したが、本発明は以下のような場合にも適用できることはいうまでもない。

（１）基板材料や連続膜半導体層の材料、および発光素子を構成する材料が異なる場合（例えば、基板がＳｉ、連続膜半導体層がＧａＡｓ、の場合や基板がＳｉ、ＧａＡｓで連続膜層がＧａＮである場合、等）。

（２）成長抑制構造である選択成長マスクの材料が異なる場合（SiN_x、SiO_x、AlO_x、等）や、構造自体が選択成長マスクや溝構造以外の場合（例えば、サファイア基板上に形成したリッジストライプやその他の凹凸構造、等）。

（３）連続膜半導体層を形成後、発光層形成前に基板を完全に除去するように工程の順番を変更した場合。

【００４７】

【発明の効果】以上のように、本発明を適用することにより、基板とは格子定数や熱膨張係数が異なる連続膜半導体層上に半導体発光素子を作製した場合、発光効率の低下を防止し、歩留まり良く発光効率の高い発光ダイオードや半導体レーザを実現できた。また、本発明により、これらの発光素子において実用上十分な信頼性を確保することが可能となった。

【図面の簡単な説明】

【図１】本発明の実施の形態１の半導体レーザ素子の断面図である。

【図２】本発明の実施の形態１の半導体レーザ素子の作製工程図である。

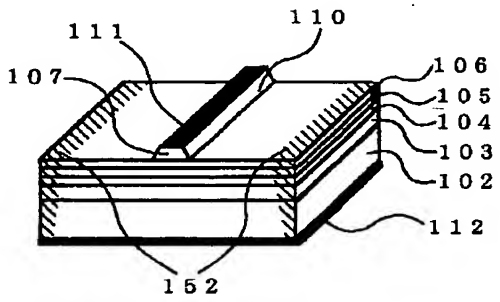
【図３】成長マスクの直上領域からメサストライプまでの距離に対するメディアン寿命を示す図である。

【図４】本発明の実施の形態２の半導体発光素子の断面図である。

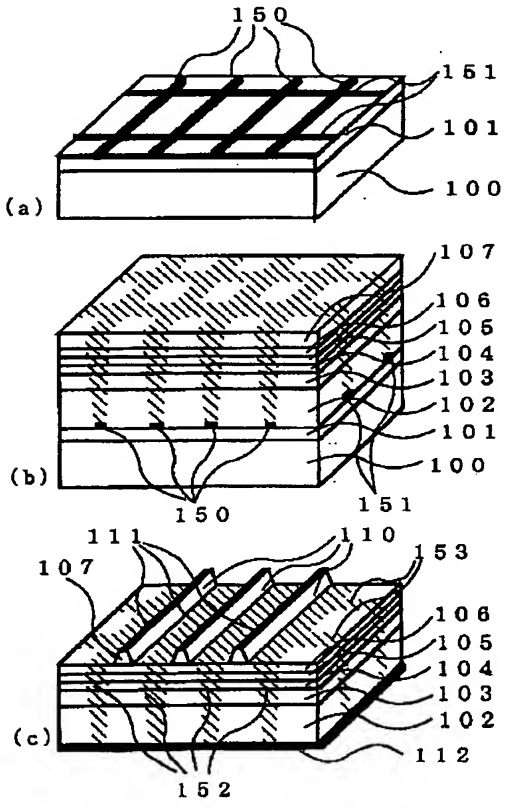
【図５】本発明の実施の形態２の半導体発光素子の作製工程図である。

【図６】本発明の実施の形態３の半導体レーザ素子の断面図である。
【図７】本発明の実施の形態４の半導体発光素子の上面図である。
【図８】従来の半導体発光素子の作製工程図である。
【図９】従来の半導体発光素子の構造を示す図である。
【図１０】成長抑制構造からの距離に対する結晶転移の面密度を示す図である。
【符号の説明】
１００　サファイア基板
１０１、６０１　ＧａＮバッファ層
１０２、６０２、４０１　ｎ－ＧａＮ連続膜層
１０３、６０３、４０２　ｎ－ＧａＮバッファ層
１０４、６０４　ｎ－$Al_{0.1}Ga_{0.9}N$クラッド層
１０５、６０５　多重量子井戸活性層
１０６、６０６、４０５　ｐ－$Al_{0.1}Ga_{0.9}N$クラッド層
１０７、６０７　４０６　ｐ－ＧａＮコンタクト層
１１０、６１０　メサストライプ
１１１、６１１、４０８、７１１　ｐ型電極
１１２、６１２、４０７、７１２　ｎ型電極
１５０、１５１、６５０、６５１　選択成長マスク
１５２、１５３、６５２、６５３　直上領域
４００　サファイア基板
４０３　$In_{0.2}Ga_{0.8}N$歪み緩和層
４０４　$In_{0.45}Ga_{0.55}N$単一量子井戸活性層
４１０　メサ
４５０　溝構造
４５１、７５１　直上領域
６００　ＳｉＣ基板
７１０　メサ

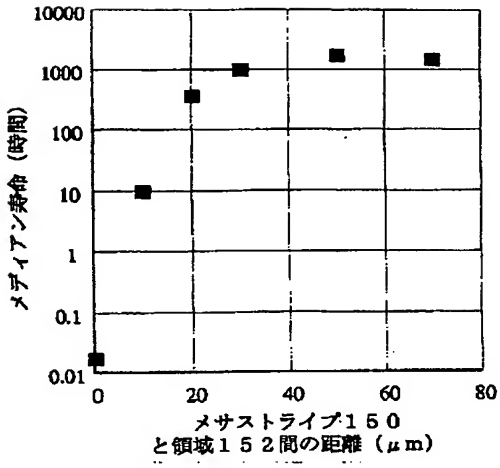
【図１】



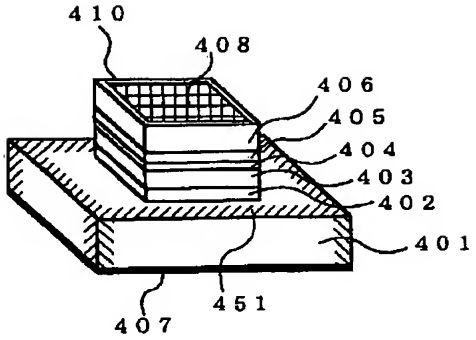
【図２】



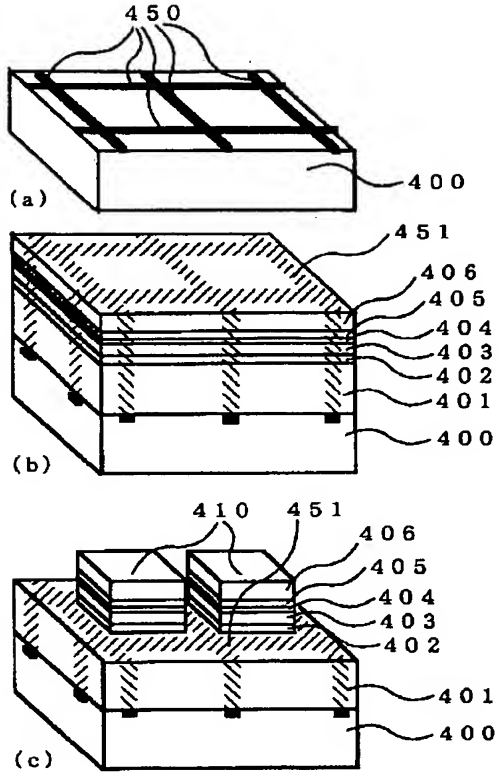
【図３】



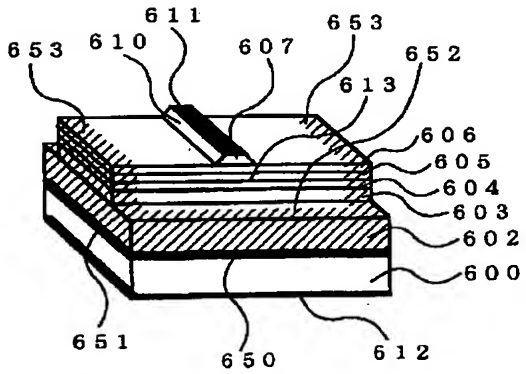
【図４】


４１０
４０８
４０６
４０５
４０４
４０３
４０２
４０１
４０７
４５１

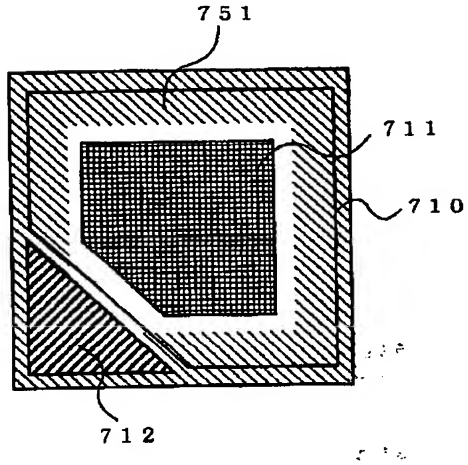
【図５】


４５０
４００
(a)
４５１
４０６
４０５
４０４
４０３
４０２
４０１
４００
(b)
４１０
４５１
４０６
４０５
４０４
４０３
４０２
４０１
４００
(c)

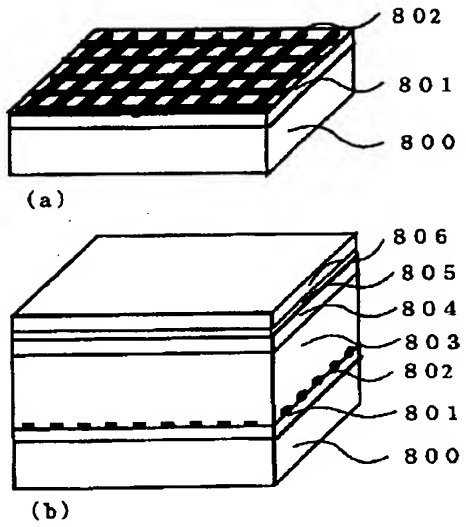
【図６】


６１１
６５３
６１０
６０７
６５３
６５２
６１３
６０６
６０５
６０４
６０３
６０２
６００
６５１
６５０
６１２

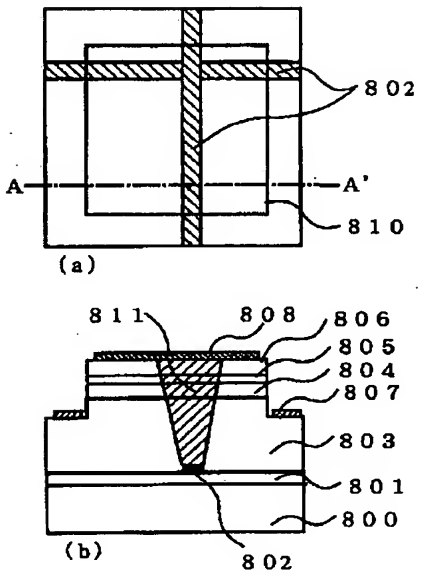
【図７】


７５１
７１１
７１０
７１２

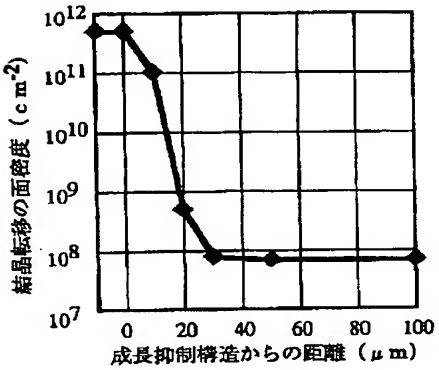
【図８】


８０２
８０１
８００
(a)
８０６
８０５
８０４
８０３
８０２
８０１
８００
(b)

【図９】


８０２
A
A'
８１０
(a)
８１１
８０８
８０６
８０５
８０４
８０７
８０３
８０１
８００
(b)
８０２

【図１０】


10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
結晶転移の面密度（cm^{-2}）
0
20
40
60
80
100
成長抑制構造からの距離（μm）

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The semi-conductor light emitting device characterized by forming in fields other than said growth suppression structure right above field the luminescence field which is the semi-conductor light emitting device which has a continuation film semi-conductor layer including the growth suppression structure right above field obtained with the crystal growth to a growth suppression structure top, and the barrier layer which generates light, and generates light by current impregnation among these barrier layers.
[Claim 2] Said luminescence field is a semi-conductor light emitting device according to claim 1 characterized by being formed in the location which separated 30 micrometers or more from the growth suppression structure right above field.
[Claim 3] The semi-conductor light emitting device characterized by removing said barrier layer in the field between said luminescence field and said growth suppression structure right above field.
[Claim 4] The 1st process which forms growth suppression structure on a substrate, and the 2nd process which forms the continuation film semi-conductor layer from which said substrate and lattice constant, or a coefficient of thermal expansion differs so that both said substrate and said growth suppression structure may be covered continuously, The manufacture approach of the semi-conductor light emitting device characterized by having the 3rd process which forms the multilayer-structure object containing the barrier layer which generates light on said continuation film semi-conductor layer, and the 4th process which forms the structure for specifying the luminescence field in said barrier layer except for the right above field of said growth suppression structured division.
[Claim 5] The manufacture approach of the semi-conductor light emitting device according to claim 4 which is the manufacture approach of a semi-conductor light emitting device of having the process which divides a semi-conductor light emitting device into two or more semi-conductor light emitting devices from a wafer, and is characterized by including the 5th process which divides a semi-conductor light emitting device from a wafer so that said barrier layer of said growth suppression structure right above may not be contained in a semi-conductor light emitting device after said 4th process.
[Claim 6] The manufacture approach of a semi-conductor light emitting device according to claim 5 that said barrier layer which remains from the edge of said growth suppression structure right above to a less than 30-micrometer field is characterized by dividing a semi-conductor light emitting device so that it may not be contained in a semi-conductor light emitting device in said 5th process.

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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a semi-conductor light emitting device with the high dependability formed on the substrate with the semiconductor material with which a lattice constant or a coefficient of thermal expansion differs especially from a substrate about a semi-conductor light emitting device.
[0002]
[Description of the Prior Art] When forming in up to the substrate with which a lattice constant differs from the crystal ingredient which constitutes a semi-conductor light emitting device 3% or more, or when growing up a semiconducting crystal to be up to the substrate with which coefficients of thermal expansion differ 10% or more, the attempt which the ingredient which constitutes a semi-conductor light emitting device, and the crystal ingredient with almost equal (a lattice constant and a coefficient of thermal expansion less than 1%) a lattice constant and a coefficient of thermal expansion were grown up thickly, formed the continuation film semi-conductor layer upwards on the substrate first, and forms a semi-conductor light emitting device is made. It is reported that a crystal defect reduces the semi-conductor layer which carried out the laminating on the continuation film semi-conductor layer. The example by the conventional technique which was made to carry out crystal growth of the GaN layer thickly, formed the continuation film semi-conductor layer on silicon on sapphire 800, and formed blue light emitting diode (LED) on it as an example of representation of such a light emitting device at drawing 8 is shown.
[0003] The production approach of LED of this conventional example is explained. On silicon on sapphire 800, the GaN layer 801 is first grown up into 5-micrometer thickness thickly by halide vapor growth (HVPE law). Next, the selective growth mask 802 which consists of SiO2 is formed in GaN layer 801 front face in the shape of a grid (form where SiO2 stripe of 20-micrometer width of face of 200-micrometer pitch intersects perpendicularly mutually). The process sectional view produced by the above is shown in drawing 8 (a).
[0004] next, this silicon-on-sapphire 800 top -- HVPE -- 300-micrometer thickness growth of the n mold GaN continuation film semi-conductor layer 803 is carried out by law. It grew up to be also right and left so that the n mold GaN continuation film semi-conductor layer 803 which grew according to the HVPE process at this time might be jutted out to up to the mask 802 for selective growth which that thickness follows on increasing and consists of SiO2, although growth begins from the part which silicon on sapphire 800 exposed, and the selective growth mask 802 top which finally consists of SiO2 of 20-micrometer width of face was covered. Thus, the n mold GaN continuation film semi-conductor layer 803 with a flat front face was formed.
[0005] Next, the n-GaN cladding layer 804, the InGaN barrier layer 805, and the p-GaN contact layer 806 were formed in the wafer with which the n mold GaN continuation film semi-conductor layer 803 was formed on this silicon on sapphire 800 of metal-organic chemical vapor deposition (MOCVD law). The process sectional view produced by the above is shown in drawing 8 (b).
[0006] Next, as shown in top-face structural drawing of LED of the (a) conventional example of drawing 9 , and the A-A' sectional view of the (b) conventional example LED, it left the luminescence field 810 of 300-micrometer angle, and it removed so that the surroundings of it might be surrounded, and the p-GaN contact layer 806, the InGaN barrier layer 805, and the n-GaN cladding layer 804 might be penetrated using a usual photolithography technique and a usual dry etching technique, and the n mold GaN continuation film semi-conductor layer 803 was exposed. Finally, p mold electrode 808 which has n

mold electrode 807 on the front face of the n mold GaN continuation film semi-conductor layer 803, and has light transmission nature on the front face of the p-GaN contact layer 806 of 300-micrometer angle was formed, respectively. Thus, from the produced wafer, the scribe was carried out around the luminescence field 810, and each LED was started and it considered as the component. Thus, LED of the conventional example to produce is reported.

[0007]

[Problem(s) to be Solved by the Invention] However, the result to which the artificer concerned examined the property of LED which carried out in this way and was produced, The luminous efficiency (conversion efficiency to an electronic photon) at the time of pouring in a 20mA current differs from 0.3 to 10% greatly by each component. It newly became clear that the yield from which 5% or more of desired luminous efficiency is acquired is very as low as 2%, and that the luminous efficiency of all components decreased sharply to about 30% or less at the time of test initiation in the initial reliability trial of about 100 hours under 80-degree C conditions.

[0008] As a result of performing these examination with the artificer concerned detailed about the defect of a component conventionally, the following facts became clear.

(1) Luminescence in InGaN barrier layer 805 part located in the selective growth mask right above field 811 to which the selective growth mask 802 exists is very small. Moreover, when the selective growth mask right above field 811 was located in the central field of the luminescence field 810 from the boundary region of the luminescence field 810 of a chip, it also turned out that the decline in this luminous efficiency becomes remarkable especially. Thereby, luminous efficiency changes a lot by whether the selective growth mask right above field 811 is located in the part of luminescence field 810 throat.

(2) Also in the component of above-mentioned poor dependability, as for the InGaN barrier layer 805 of the selective growth mask right above field 811 (width of face of 20 micrometers), luminescence is hardly accepted after reliability-trial transit of 100 hours at a total of a 80-micrometer field including about 30 micrometers of both sides of the near.

[0009] As a result of performing crystal analysis of the conventional example component furthermore, it became clear that penetrate the n mold GaN continuation film semi-conductor layer 803 with a thickness of 300 micrometers, and crystal transition concentrates and is introduced into the InGaN barrier layer 805 located in the selective growth mask right above field 811. The result of having measured the distance from selective growth mask 802 edge for the consistency of the crystal transition in the InGaN barrier layer 805 as a parameter to drawing 10 is shown. Crystal transition of consistency 1012cm-2 was concentrating on the InGaN barrier layer 805 of the selective growth mask right above field 811 with a width of face of 20 micrometers, and transition of 1011cm-2 was observed also in the location which separated 10 micrometers from the edge of the selective growth mask 802 further. Crystal transition decreased as it separated from the edge of the selective growth mask 802, and in the InGaN barrier layer 805 of the location distant 30 micrometers or more, crystal transition decreased even to 107-108cm-3. Such an inclination was observed in any part of the wafer produced as mentioned above.

[0010] Moreover, the selective growth mask right above field 811 was included in the luminescence field in semiconductor laser by the same approach on the above n mold GaN continuation film semi-conductor layers 803, it was as large as 700mA, and the component life also had the oscillation threshold current very as short as about 1 second in the room temperature.

[0011] As mentioned above, in the conventional technique, the following troubles became clear.

(1) In the light emitting device on the continuation film semi-conductor layer produced using the selection grown method, since decline in luminous efficiency is seen in the selective growth mask right above field 811, with the chip in which a selective growth mask right above field is included, luminous efficiency falls to a luminescence field dramatically.

(2) The life of the semiconductor laser component formed on the GaN continuation film was short, and the semiconductor laser component was not obtained.

[0012] For this reason, it was impossible to have prevented a fall and poor dependability of the luminous efficiency caused in the semi-conductor light emitting device which the continuation film semi-conductor layer which has a different lattice constant from a substrate and a coefficient of thermal expansion is grown up, and is formed on it on a substrate from a lattice constant difference or a coefficient-of-thermal-expansion difference.

[0013] Therefore, it aims at preventing the decline in the luminous efficiency in the case of having formed upwards the continuation film semi-conductor layer from which a substrate, a lattice constant,

or a coefficient of thermal expansion differs using partial growth suppression structure, and forming a semi-conductor light emitting device further, and aggravation of dependability.
[0014]
[Means for Solving the Problem] Claim 1 of this invention is constituted by forming in fields other than said growth suppression structure right above field the luminescence field which is the semi-conductor light emitting device which has a continuation film semi-conductor layer including the growth suppression structure right above field obtained with the crystal growth to a growth suppression structure top, and the barrier layer which generates light, and generates light by current impregnation among these barrier layers.
[0015] Claim 2 in this invention is constituted by being formed in the location where said luminescence field separated 30 micrometers or more from the growth suppression structure right above field, and claim 3 consists of fields between said luminescence field and said growth suppression structure right above field for it by removing said barrier layer further.
[0016] The 1st process at which claim 4 forms growth suppression structure on a substrate on the other hand, and the 2nd process which forms the continuation film semi-conductor layer from which said substrate and lattice constant, or a coefficient of thermal expansion differs so that both said substrate and said growth suppression structure may be covered continuously, The 3rd process which forms the multilayer-structure object containing the barrier layer which generates light on said continuation film semi-conductor layer, It is constituted by having the 4th process which forms the structure for specifying the luminescence field in said barrier layer except for the right above field of said growth suppression structured division. Further claim 5 It is the manufacture approach of a semi-conductor light emitting device of having the process which divides a semi-conductor light emitting device into two or more semi-conductor light emitting devices from a wafer. After said 4th process, are constituted by including the 5th process which divides a semi-conductor light emitting device from a wafer so that said barrier layer of said growth suppression structure right above may not be contained in a semi-conductor light emitting device, and claim 6 is set at said 5th process. Said barrier layer which remains from the edge of said growth suppression structure right above to a less than 30-micrometer field is constituted by dividing a semi-conductor light emitting device so that it may not be contained in a semi-conductor light emitting device.
[0017]
[Embodiment of the Invention] It explains using the example which carried out this invention below. (Gestalt 1 of operation) An example of a semiconductor laser component which carried out this invention to drawing 1 is shown. This semiconductor laser component consists of the n-GaN continuation film semi-conductor layer 102, the n-GaN buffer layer 103, the n-aluminum0.1Ga0.9N cladding layer 104, a multiplex quantum well barrier layer 105, a p-aluminum0.1Ga0.9N cladding layer 106, and a p-GaN contact layer 107, and consists of a mesa stripe 110 for specifying the luminescence field of laser as a ridge waveguide, a p mold electrode 111 further for current impregnation, and an n mold electrode 112.
[0018] Next, the making process of this example component is explained using drawing 2 . first, a silicon-on-sapphire 100 top -- MOCVD -- 1-micrometer thickness growth of the GaN buffer layer 101 is carried out by law. next, the usual photolithography technique after carrying out 0.4-micrometer thickness formation of the SiO2 film by the usual spatter on the front face of the GaN buffer layer 101 and an etching technique -- width of face of 10 micrometers -- pitch 150micrometer -- periodic -- the selective growth mask 150 and width of face of 10 micrometers which consist of SiO2 -- pitch 500micrometer -- periodic -- the selective growth mask 151 which consists of SiO2 formed in the configuration which intersects perpendicularly mutually. The process sectional view of the semiconductor laser component produced by the above is shown in drawing 2 (a).
[0019] then, this wafer top -- HVPE -- 150-micrometer thickness growth of the n-GaN continuation film semi-conductor layer 102 was carried out by law. Growth of 150-micrometer thickness completed substrate temperature with the growth for 35 minutes as 1020 degrees C. In the phase which growth took place only in the field which the GaN buffer film 101 exposed in early stages of growth like explanation in the conventional example in order that the selective growth masks 150 and 151 might work as growth suppression structure at the time of this growth, growth progressed in the longitudinal direction on the selective growth mask 150 and 151 gradually, and growth of 150 micrometer thickness finally ended, the n-GaN continuation film semi-conductor layer 102 is presenting the continuation film, and that front face became smooth.
[0020] By the MOCVD method, succeedingly next, on this n-GaN continuation film semi-conductor layer

102 0.5-micrometer thickness and the n-aluminum0.1Ga0.9N cladding layer 104 for the n-GaN buffer layer 103 0.2-micrometer thickness, The multiplex quantum well barrier layer 105 and the p-aluminum0.1Ga0.9N cladding layer 106 which consist of In0.25Ga0.75N well layer two-layer of 4nm thickness, and three layers of In0.05Ga0.95N barrier layers of 3nm thickness 0.2-micrometer thickness, 0.7-micrometer thickness growth of the p-GaN contact layer 107 was carried out. The process sectional view of the semiconductor laser component produced by the above is shown in drawing 2 (b).

[0021] Then, the mesa stripe 110 with a width of face [of 2 micrometers] and a height of 0.7 micrometers was formed in fields other than right above field 152 of the selective growth mask 150 almost in parallel with the selective growth mask 150. the selective growth mask 150 with which the mesa stripe 110 observes and adjoins each other from the upper part of a component at this time -- it was made to be mostly located in the center A usual photolithography technique and a usual dry etching technique were applied to formation of this mesa stripe 110. Then, after forming stripe-like p mold electrode 111 in a top face for the mesa stripe 110, Wafer thickness is set to about 120 micrometers by grinding a wafer rear face (). Namely, silicon on sapphire 100, the GaN buffer layer 101, and the selective growth masks 150 and 151 are removed completely. The n-GaN continuation film semi-conductor layer 102 formed n mold electrode 112 all over the rear face which it is made to expose to a wafer rear face, and the n-GaN continuation film semi-conductor layer 102 exposed. The process sectional view of the semiconductor laser component produced by the above is shown in drawing 2 (c).

[0022] Next, the mirror side which constitutes a laser cavity by cleavage was formed. This cleavage process is the following, and was made and carried out. First, the marking-off blemish was put into two near [on the rear face of a wafer (namely, the n-GaN continuation membrane layer 103 side)] the corner, cleavage was carried out to the direction and the parallel direction in which the selective growth mask 151 was formed, in the location of this marking-off blemish, and the laser resonator mirror was formed. At this time, two marking-off blemishes are formed in the location which separated 50 micrometers from the edge part of the selective growth mask 151 which adjoins mutually, and the right above field 153 of the selective growth mask 151 was made not to be included in a laser component. Therefore, laser cavity length was 400 micrometers. The scribe of the part of the right above field 152 of the selective growth mask 150 was carried out to the last, and it divided into each laser chip. The laser component shown in drawing 1 through the above process is completed.

[0023] The laser component produced as mentioned above has realized laser oscillation by the threshold current of 25mA. Moreover, except for the laser component which results this laser component within 50 hours of the first stage at failure as a result of carrying out a reliability trial under 50-degree-C ambient atmosphere and the condition of 3mW output, the life of 1000 hours or more could be checked in almost all components, and the median life (time amount to which the component of the examined one half breaks down) was 1500 hours. This dependability is sufficient property even when using the component concerned as the light source for optical disks. An improvement of this dependability with this laser component In selective growth mask [which is the growth suppression structure formed in order to grow up the n-GaN continuation film semi-conductor layer 102] 150, and 151 top So that the right above fields 152 and 153 which a crystal defect concentrates may not be included to the luminescence field (in this case, part in which the mesa stripe 110 with which a current is alternatively poured into a barrier layer 105 is formed) of a laser component It can be understood as what is depended on having set up the relative position for the configuration of the selective growth masks 150 and 151, and the cleavage of a laser resonator mirror to the relative position and the selective growth mask 151 of the mesa stripe 110 to the selective growth mask 150.

[0024] With the laser component which carried out the above-mentioned invention, it is formed so that it may become the center of right above field 152 comrades of the selective growth mask 150 which adjoins the mesa stripe 110 (into namely, part which separated 70 micrometers from the edge of the selective growth mask 150). With the same structure as the above-mentioned example component, the laser component to which the distance from right above field 152 (namely, selective growth mask 150) edge of the mesa stripe 110 was changed with 0 micrometer, 10 micrometers, 20 micrometers, 30 micrometers, 50 micrometers, and 70 micrometers (namely, when the mesa stripe 110 is formed in the right above field 152) was produced, and the same reliability trial as the above was carried out. At this time, the scribe location of an isolation sake was made into near the core of the mesa stripe 110 which adjoins also in which component, and set constant the relative distance with the mesa stripe 110 of a scribe location. The result is shown in drawing 3 . An axis of abscissa shows the distance from the core of the right above field 152 to the mesa stripe 110, and the axis of ordinate shows the median life. In order to secure from this result the median life of 1000 hours or more needed practically, it turned out

that it is required to form the mesa stripe 110 in the location which separated 30 micrometers or more from the right above field 152.
[0025] (Gestalt 2 of operation) Next, the case where this invention is applied to light emitting diode is described. Structural drawing of the 2nd operation morphological child is shown in drawing 4 . It consists of the n-GaN continuation film semi-conductor layer 401, the n-GaN buffer layer 402, the In0.1Ga0.9N strain relaxation layer 403, the In0.5Ga0.5N single quantum well barrier layer 404, the p-aluminum0.2Ga0.8N antiflashing layer 405, a p-GaN contact layer 406 and an n mold electrode 407, and a p mold electrode 408. Moreover, the luminescence field is specified by the mesa 410 with the component of this example.
[0026] Next, the production approach of this light emitting device is explained. First, the slot structure 450 with a width of face [of 40 micrometers] and a depth of 50 micrometers is formed in silicon-on-sapphire 400 front face in the shape of a grid in 400-micrometer pitch by dicing. The process sectional view of the semiconductor device produced by the above is shown in drawing 5 (a).
[0027] Next, by the HVPE method, the n-GaN continuation film semi-conductor layer 401 with a thickness of 300 micrometers is grown up. Although the growth as a flat field cannot do the n-GaN continuation film semi-conductor layer 401 in the early stages of growth since there is slot structure 450 formed in silicon on sapphire 400 at this time, the slot structure 450 will be gradually buried with the growth from a wall on either side as growth thickness is increased, and the slot on surface will be embedded evenly. That is, the same effectiveness as a thing with slow growth in a slot 450 could be realized effectually, and the continuous front face was able to use the n-GaN continuation membrane layer 401 as the flat single layer at the time of 300-micrometer growth termination.
[0028] next, molecular-beam epitaxial ** (MBE law) -- on the n-GaN continuation film semi-conductor layer 401, 0.05-micrometer thickness and the In0.45Ga0.55N single quantum well barrier layer 404 were carried out for 0.4-micrometer thickness and the In0.2Ga0.8N strain relaxation layer 403, and 0.4-micrometer thickness growth of 0.1-micrometer thickness and the p-GaN contact layer 406 was carried out [the n-GaN buffer layer 402] for 4nm thickness and the p-aluminum0.1Ga0.9N antiflashing layer 405. The process sectional view of the light emitting device produced by the above is shown in drawing 5 (b).
[0029] Furthermore, it left periodically 300-micrometer angle mesa 410 which contains the In0.45Ga0.55N single quantum well barrier layer 404 using a usual photolithography technique and a usual dry etching technique, the field in the meantime was etched by 100-micrometer width of face, and the n-GaN continuation film semi-conductor layer 401 was exposed on the etching base. That is, the etched field became the configuration of the shape of a grid of 400-micrometer pitch, and the right above field 451 of the slot structure 450 which includes by this many defects by which MBE growth was carried out on the slot structure 450, and the In0.45Ga0.55N single quantum well barrier layer 404 contained around it were removed completely. With the gestalt of this operation, the slot structure 450 turns into growth suppression structure. The process sectional view of the light emitting device produced by the above is shown in drawing 5 (c).
[0030] Next, the rear face of a wafer was ground, after removing silicon on sapphire 400 completely and exposing the n-GaN continuation film semi-conductor layer 401 at the wafer rear face, n mold electrode 407 was formed in this n-GaN continuation film semi-conductor layer 401, and p mold electrode 408 of light transmission nature was formed in the front face of a mesa 410. It considered as each light emitting diode chip by carrying out a scribe to the last in the right above field 451 of the slot structure 450. The process sectional view of the light emitting device produced by the above is shown in drawing 4 .
[0031] Thus, the yield of the component of **, alias *******, and 5% or more of conversion efficiency it can consider that is satisfactory practically was as high as 85% in the conversion efficiency to the photon of the electron of the produced light emitting diode. Furthermore, when the reliability trial was carried out for this example component on the same conditions as the conventional example component, 95 - 103% of luminescence reinforcement at the time of test initiation could be obtained after 1000-hour progress, and the dependability which is satisfactory practically was secured.
[0032] The luminescence field in the light emitting device of this operation gestalt is equivalent to the mesa 410 section in which the In0.45Ga0.55N single quantum well barrier layer 404 remains. Since the mesa 410 is formed in the field except the right above field 451 of the slot structure 450 used as growth suppression structure at the time of n-GaN continuation film semi-conductor layer 401 growth, in no produced light emitting devices, the right above field 451 of the slot structure 450 is included in the luminescence field. Moreover, the width of face from which the In0.45Ga0.55N single quantum well

barrier layer 404 was removed by etching is 100 micrometers, and the luminescence field of the mesa 410 section will be formed in the place which separated 30 micrometers from the edge of the slot structure 450 with a width of face of 40 micrometers. the dependability which can obtain a component with luminous efficiency high as mentioned above with the sufficient yield , and be satisfactory be realizable -- HVPE -- law and MOCVD -- the effect of the crystal defect intensively introduced into the right above field 451 of the slot structure 450 by the crystal growth process by law do not have a bad influence on luminescence by the In0.45Ga0.55N single quantum well barrier layer 404 , but be consider because it became possible to arrange a luminescence field with a controllability sufficient into a part with comparatively few crystal defects .

[0033] In addition, in the light emitting device of the above-mentioned operation gestalt, a light emitting device making process and structure presupposed that it is almost equivalent, and made the light emitting device at the time of changing only the pitch of the slot structure 450 from 400 micrometers of the above-mentioned example to 500 micrometers and 300 micrometers as an experiment. Also in this case, the magnitude and the production pitch of a mesa 410 were considered as as [300 micrometers 400 micrometers, and the above-mentioned operation morphological child], respectively. When the luminescence property of these light emitting devices was measured, with the component which made the pitch of a slot 450 small with 300 micrometers, the yield from which 5% or more of luminous efficiency is acquired decreased sharply with 16%. On the other hand, in 500 micrometers and the opened light emitting device, it was 38%. This shows that it is important that the pitch of the slot structure 450 is the same as the production pitch of the mesa 410 which forms each light emitting diode. Therefore, in order to produce many light emitting devices from the wafer of the same area, it should be made for the right above field 451 of slot structure not to contain to a luminescence field in all light emitting devices. It cannot be overemphasized that it may put on this semantics and the pitch of the slot structure 450 may be made into the integral multiple of a mesa 410 production pitch.

[0034] (Operation gestalt 3) Next, the operation gestalt which made the growth suppression structure itself remain for a laser component is explained. Component structural drawing of this operation gestalt is shown in drawing 6 . The component structure of this operation gestalt The n-SiC substrate 600, The GaN buffer layer 601, the n-GaN continuation film semi-conductor layer 602, The multiplex quantum well barrier layer 605 which consists of the n-GaN buffer layer 603, three layers of In0.1Ga0.85aluminum0.05N barrier layers of 604 or 3nm thickness of n-aluminum0.1Ga0.9N cladding layers, and In0.2Ga0.8N quantum well layer two-layer of 3nm thickness, the p-aluminum0.1Ga0.9N cladding layer 606 and the p-GaN contact layer 607 -- since -- it has the becoming semi-conductor layer structure, p mold electrode 611 and n mold electrode 612, the mesa stripe 610 which specifies waveguide and a current path further, and the etched mirror 613 used as a resonator mirror.

[0035] Below, the production approach of the laser component of this operation gestalt is explained. (Since process drawing is similar with drawing 2 , it is omitted here.) First, on the n-SiC substrate 600, it formed so that the selective growth mask 650 whose period is 100 micrometers, and the selective growth mask 651 whose period width of face is 400 micrometers in 10 micrometers might intersect perpendicularly mutually by width of face of 10 micrometers which consists of SiNx. this wafer top -- MOCVD -- law -- the GaN buffer layer 601 -- 30nm thickness and the n-GaN continuation film semi-conductor layer 602 -- 100-micrometer thickness and the n-GaN buffer layer 603 -- 0.1 micrometers and the n-AlGaN cladding layer 604 -- 0.3-micrometer thickness, the multiplex quantum well barrier layer 605, and the p-AlGaN cladding layer 606 -- 0.3-micrometer thickness and the p-GaN contact layer 607 -- 1.0-micrometer thickness -- crystal growth is carried out continuously. Although thickness remained in the condition 30 micrometers or less, the non-grown up part remained on the selective growth mask 650 and 651 and the crystal was not presenting the continuous film in growth of the n-GaN continuation film semi-conductor layer 602 at this time In the phase in which growth was furthermore continued and thickness amounted to 100 micrometers, the single film which was flat like the operation gestalt 1 as for n-GaN continuation film semi-conductor layer 602 front face, and continued is presented, and each class 603-607 contained in the laminated structure continuously formed on it also grew as a flat layer.

[0036] Next, a usual photolithography technique and a usual etching technique were used, and the mesa stripe 610 with a height [of 0.8 micrometers] and a width of face of 2 micrometers was formed in parallel with the selective growth mask 651. This mesa stripe 610 not only forms laser waveguide in a barrier layer 605, but specifies the path of the current poured into a barrier layer 605 into the part near directly under [mesa stripe 610], and it serves to change an electron into a laser beam efficiently. In this process, the mesa stripe 610 was formed so that spacing of the center of the right above field 653

of the selective growth mask 651 of both sides, i.e., the edge of the selective growth mask 651 and the edge of the mesa stripe 610, might be set to 39 micrometers.
[0037] Next, the photolithography technique and dry etching technique for the usual etched mirror formation were used, and the etched mirror 613 used as a laser resonator mirror was formed. At this time, the etched mirror 613 was parallel to the selective growth mask 650, and it etched until it etched into the field with a full of 100 micrometers centering on the right above field 652 of the selective growth mask 650 and the n-GaN continuation film semi-conductor layer 602 was exposed to the etching base so that the barrier layer 605 of the right above field 652 of the selective growth mask 650 might be removed from etching. The resonator mirror of a lot which should serve as a laser cavity according to this process was formed, and the cavity length in the laser component of this operation gestalt could be 300 micrometers. That is, it means carrying out etching for etched mirror formation in a cycle of [as the period of the selective growth mask 650 / same] 400 micrometer.
[0038] Finally, after forming p mold electrode 611 in mesa stripe 610 top face and forming n mold electrode 612 all over n-SiC substrate 600 rear face, it divided into each laser component by carrying out a scribe in the part of the right above fields 652 and 653 of the selective growth masks 650 and 651.

[0039] When the reliability trial under the conditions of 5mW optical output was carried out for the laser component of this operation gestalt under 60-degree-C ambient atmosphere of the operation gestalt 2, except for the component which showed abnormality degradation of initial 24 hours, it has checked having the life of 1000 hours or more altogether. The median life in this case was about 1600 hours. Thus, it is not included in the mesa stripe 610 whose right above field 652 of the selective growth mask 650 is a luminescence field at all that reliable laser was realizable, but it is imagined to be the effectiveness which the barrier layer 605 of only a field with few crystal defects which cause degradation of a laser component has contributed to luminescence.
[0040] By the way, in 1 of an operation gestalt, the cleavage location of a laser component was restricted to the part outside the right above field 152 of the selective growth mask 150. This is for avoiding deteriorating in an instant, when cleavage is carried out in the right above field 152 of the selective growth mask 150, the right above field 152 of the selective growth mask with which many crystal defects are included near the cleavage plane which it tends to destroy in the mesa stripe 110 used as the luminescence field of laser is included and a component is operated. However, when cleavage was carried out near the right above field 152 of the selective growth mask 150 as in the operation gestalt 1 in parallel with the right above field 152 of the selective growth mask 150, the level difference arose in the cleavage plane partially, and there was a case where the right above field 152 of the selective growth mask 150 was included in the mesa stripe 110 with some components as a result. Many crystal defects are included to the right above field 152 of the selective growth mask 150, this is weak as a crystal, and it is considered to be the cause that it is easier to be divided. That is, in spite of a crystal's carrying out cleavage in the right above field 152 of the selective growth mask 150 and having the **** property with one, it is because cleavage of the near was carried out with the operation gestalt 1. The yield when the same phenomenon is observed not only when cleavage divides a component, but when a scribe divides a component, and a controllability improves this phenomenon in parallel a scribe to the right above field 153 of the selection mask 151 in about 153 right above field of the selection mask 151 compared with a scribe ****** case in the right above field 153 of the selection mask 151 was low.
[0041] Since the component division location by the scribes of all the 4th page at the time of dividing a component can be limited to the right above fields 652 and 653 of the selective growth masks 650 and 651 by this operation morphological child on the other hand, At the time of component division, the scribe happened in the position, the right above field 652 of a selection mask was not included in the mesa stripe 610, and the configuration of a component did not shift from a predetermined configuration (it is the Nogata form, as it observes from the upper part and is shown in drawing 6). Thereby, also in the component shape recognition at the time of mounting a component, the error was able to be reduced and the component mounting yield has also been improved. This point was also a big merit in this operation morphological child.
[0042] (Operation gestalt 4) Next, the operation gestalt of this invention when the barrier layer of the right above field of growth suppression structure remains for the component is explained using the example of light emitting diode. Structural drawing observed from the top face of the light emitting device of this operation gestalt to drawing 7 is shown. The formation approach of a GaN continuation membrane layer and the semi-conductor laminated structure presupposed that it is the same as the

case of the operation gestalt 2 (in explanation of this example of an operation gestalt, the mark of common each class presupposes that it is the same as that of an example 2). Differing from the operation gestalt 2 is the point which the configuration of the mesa 710 containing the In0.45Ga0.55N single quantum well barrier layer 404 has a configuration like drawing 7 , and enlarged the size with 390-micrometer angle. For this reason, in the light emitting device of this operation gestalt, it has the form where the In0.45Ga0.55N single quantum well barrier layer 404 located in the right above field 751 of the growth suppression structure slack slot structure 450 at the time of n-GaN continuation membrane layer 401 growth was contained in the mesa 710.

[0043] However, in the light emitting device of this operation gestalt, it has arranged to the central field of a mesa 710 by using p mold electrode 711 as 300-micrometer angle. That is, in the 30-micrometer field, p mold electrode was made not to be formed from the edge of the right above field 751 of the slot structure 450, and the right above field 751. On the other hand, n mold electrode 712 was formed in one corner of a light emitting device where the In0.45Ga0.55N single quantum well barrier layer 404 was removed like drawing 7 .

[0044] The p-GaN contact layer 406 consists of p-GaN with comparatively high resistivity, and since the current poured in from p mold contact layer 406 and p mold electrode 711 by considering as such a configuration has 0.4 micrometers and the thin thickness of those, in p mold contact layer 406, a current can hardly diffuse it in a longitudinal direction, but it can pour a current only into the In0.45Ga0.55N single quantum well barrier layer [directly under] 404 of p mold electrode 711.

[0045] As a result of evaluating the property of the light emitting device of the operation gestalt concerned, the chip which has 5% or more of electronic-photon conversion efficiency amounted to 79 of inspected %, and the improvement more marked than the light emitting device constituted by the conventional technique was accepted. Moreover, when the reliability trial (conditions are the same as the operation gestalt 2) of these light emitting devices was performed, the luminescence brightness after 1000-hour progress became 85 - 99% of range to the luminescence brightness of the time of a trial, and it was checked that no light emitting devices are problematic practically.

[0046] As mentioned above, in the light emitting device of an operation gestalt, although the example which produced the light emitting device of a gallium nitride system using the GaN continuation film semi-conductor layer was explained, it cannot be overemphasized that this invention can be applied also when as follows.

(1) When a substrate ingredient and the ingredient of a continuation film semi-conductor layer differ from the ingredient which constitutes a light emitting device (for example, when the case where a substrate is [Si and a continuation film semi-conductor layer] GaAs**s, and a substrate are [continuation membrane layers] GaN(s) in Si and GaAs etc.).

(2) In other than (for example, a ridge stripe, other concavo-convex structures, etc. which were formed on silicon on sapphire) a selective growth mask or slot structure, the structure itself is [the cases (SiNx, SiOx AlOx, etc.) where the ingredients of the selective growth mask which is growth suppression structure differ, and].

(3) When the sequence of a process is changed so that a substrate may be completely removed before [after forming a continuation film semi-conductor layer] luminous layer formation.

[0047]

[Effect of the Invention] As mentioned above, when a semi-conductor light emitting device was produced on the continuation film semi-conductor layer in which a lattice constant and a coefficient of thermal expansion differ from a substrate by applying this invention, decline in luminous efficiency was prevented and light emitting diode and semiconductor laser with the good yield and high luminous efficiency have been realized. Moreover, this invention enabled it to secure practically sufficient dependability in these light emitting devices.

[Translation done.]

* NOTICES *

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damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view of the semiconductor laser component of the gestalt 1 of operation of this invention.
[Drawing 2] It is the making process Fig. of the semiconductor laser component of the gestalt 1 of operation of this invention.
[Drawing 3] It is drawing showing the median life over the distance from the right above field of a growth mask to a mesa stripe.
[Drawing 4] It is the sectional view of the semi-conductor light emitting device of the gestalt 2 of operation of this invention.
[Drawing 5] It is the making process Fig. of the semi-conductor light emitting device of the gestalt 2 of operation of this invention.
[Drawing 6] It is the sectional view of the semiconductor laser component of the gestalt 3 of operation of this invention.
[Drawing 7] It is the plan of the semi-conductor light emitting device of the gestalt 4 of operation of this invention.
[Drawing 8] It is the making process Fig. of the conventional semi-conductor light emitting device.
[Drawing 9] It is drawing showing the structure of the conventional semi-conductor light emitting device.
[Drawing 10] It is drawing showing the surface density of the crystal transition over the distance from growth suppression structure.
[Description of Notations]
100 Silicon on Sapphire
101 601 GaN buffer layer
102, 602, 401 n-GaN continuation membrane layer
103, 603, 402 n-GaN buffer layer
104 604 n-aluminum0.1Ga0.9N cladding layer
105 605 Multiplex quantum well barrier layer
106, 606, 405 p-aluminum0.1Ga0.9N cladding layer
107 607 406 p-GaN contact layer
110 610 Mesa stripe
111, 611, 408, 711 p mold electrode
112, 612, 407, 712 n mold electrode
150, 151, 650, 651 Selective growth mask
152, 153, 652, 653 Right above field
400 Silicon on Sapphire
403 In0.2Ga0.8N Strain Relaxation Layer
404 In0.45Ga0.55N Single Quantum Well Barrier Layer
410 Mesa
450 Slot Structure
451 751 Right above field
600 SiC Substrate
710 Mesa

[Translation done.]